EXHIBIT A

PROJECT SCOPE AND COMPENSATION

Project Understanding

The City of Durham's Department of Water Management (DWM) desires a comprehensive program for the evaluation of the finished water distribution system, update of the existing hydraulic model and to provide for a water audit to include a water loss program.

This comprehensive program will include the following five (5) key components:

- Evaluation of the existing hydraulic model components and develop the model update
- Evaluation of existing water demands and development of future water demands
- Prepare the water audit and develop the water loss program
- Evaluation and development of the Capital Improvement Plan (CIP) for the finished water distribution system for the 25 year study period in 5-year increments
- Hydraulic model training and support

Project Scope of Work

Item 1: Project Management and Coordination

Task 1.1: Project Set-Up and Kick-Off Meeting

McKim & Creed (M&C) will develop project documents and filing systems for the project that will include; project set-up, project schedule, project management plan, QA/QC plan, hard and electronic file systems and conduct an internal kick-off meeting with project team. Following project setup, M&C will conduct a project Kick-off Meeting with the project team and DWM staff to review project goals, scope of work, project schedule and administrative issues. Following the

meeting, M&C will prepare summary meeting notes and distribute to the attendees.

Task 1.2: Status Reports and Project Administration

McKim & Creed will provide monthly status reports of the progress of this scope of work to accompany monthly invoices and administer the project. Reports and invoices will be filed electronically per the requirements of the City.

Task 1.3: Project Team Meetings

McKim & Creed will meet with the DWM staff during the progress of the work and conduct the following team meetings:

- Project Kickoff Meeting
- GIS Dept.(Mike Steek)/DWM Coordination Meeting
- City's Billing Department (Martha Ziegler)
- Model Development Meeting
- Water Audit Discovery Meeting
- Evaluation of Existing Water Demands Meeting
- Model Calibration Meeting
- Water Audit Technical Memorandum Review Meeting
- Future Water Demand Projection Meeting
- Initial Model Verification Workshop
- Final Model Verification Workshop
- Hydraulic Model Development Technical Memorandum Review Meeting
- Water Loss Control Meter Verification Meeting
- Future Water Demand Technical Memorandum Review Meeting

- Water Loss Control Program Technical Memorandum Review Meeting
- Model Workshop for Existing Water Distribution System Needs
- Model Workshop for Future Water Distribution System Needs
- CIP Project Prioritization Review Meeting
- CIP Technical Memorandum Review Meeting
- Model Training Workshops
- Formal Presentations (2)

Item 2: Hydraulic Model Development

The City's current hydraulic model was developed in 2002 with a 2008 update to update flow data and system diurnal curve. Bentley WaterGEMS software has been and will continue to be utilized for the model. It is understood that DWM has an unlimited pipe version of the software for their use.

It is uncertain that the existing model was derived directly from the City's GIS database. A review of the current model and GIS layers indicates that there are differences in the alignment of the features between the existing model and the GIS layers. It is DWM's desire to restructure its GIS data such that the reconstruction of the hydraulic model can utilize the City's GIS data as the source and to facilitate future model updates.

Task 2.1: Data Collection and Review

McKim & Creed will work with DWM staff to coordinate gathering of the required system information for model creation, development and model calibration. M&C will provide to DWM a list of data necessary for completion of the Scope of Work (i.e. – GIS data, pump curves, tank elevations, record drawings, water consumption records, etc.). It is noted that the data most likely will be in the form of charts and paper records as digital data is not available. M&C will review data delivered, create a data log for tracking, identify data deficiencies and coordinate the gathering of the supplemental data to be

provided by DWM. It should be noted that DWM has already started gathering data to be made available to M&C. The included schedule assumes that DWM will provide the requested data within 4 weeks.

Task 2.2: Hydraulic Model Construction

2.2.1: Model Backgrounds – Information available through GIS including street centerlines, parcels, contours, buildings, water bodies and aerial photos will be utilized to provide a visual background and reference for a hydraulic model. M&C will collect and prepare the City's pertinent GIS layers or AutoCAD information into modeling background files so they may be displayed in a beneficial manner within the model and the animation tool. Background layers may be color coded and set to various themes to assist the users in model navigation and presentation of results.

2.2.2: Piping Network Construction – McKim & Creed will utilize the existing GIS layers and data (including water mains, tanks, pumps, valves and hydrants) to provide the base model topology for construction of the new hydraulic model by importing directly into Bentley WaterGEMS. The GIS data imported to the new model will include a link to the GIS using the City's Facility ID attribute. Data in the current GIS files are assumed to be correct. However, the existing GIS attributes associated with the model components will be compared to the corresponding information in the existing model and observed discrepancies will be brought to the attention of DWM. DWM is to provide for the review and resolution of the discrepancies. M&C will assist DWM by coordinating with the GIS Department to resolve the discrepancies in the base GIS data files. Pipeline material will be assigned to all pipelines as indicated in the GIS data but will be compared to the existing model and discrepancies noted for DWM's review and resolution. When pipeline material is unavailable or not known a default value will used as agreed upon with DWM. M&C will evaluate annexation polygons to determine approximate age of the development and age of pipe material. Generally, pipe age 1972 and earlier would be assigned as cast iron and after 1972 would be assigned as ductile iron.

It is understood that water system improvement projects that have not been updated in the GIS database may have been added to the existing hydraulic model utilizing record drawings that have been either scanned, traced or otherwise incorporated into the existing model. M&C will review the existing hydraulic model to identify these areas and prepare a list and/or screen shots of

the areas in question. In particularly, the following major water system improvement projects will need to be checked/confirmed:

- Hillandale Phase I & II
- Eastern Reinforcing Main
- Southern Reinforcing Main Phase I, IIA and IIB
- Angier Tank Connection Main
- Raleigh/Durham Interconnection Main

M&C will meet with the GIS Department and DWM to review the GIS data and existing hydraulic model to determine if there are lines indicated as future lines, future projects, abandoned lines, raw water transmission mains, water plant site lines and operational control components (like closed valves, pressure control valves, etc.) that need to be represented correctly within the GIS database and include proper attribution such that those elements will import accurately to the model or if some GIS elements may need to be omitted from the model import. These items will be documented to DWM and the GIS Department for resolution.

2.2.3: Connectivity – Once the GIS data and model topology has been updated, the model connectivity and total continuity will be verified using automated model tools and M&C's Hydraulic Model Animation Tool for network connectivity and troubleshooting. These review tools will include the following:

- system trace tool
- nodes in close proximity
- pipe split candidates
- crossing pipes
- duplicate pipes
- M&C Hydraulic Model Animation Tool

Questions sometimes arise about specific details of pipe network connectivity. In some cases, pipes are shown to cross each other, and it may not be clear from

the source document if they are connected or not. In cases such as these, M&C will first review the existing record drawings (if available) and existing valve cards on file with DWM to clarify connectivity questions. If additional clarification is needed, M&C will provide snapshot details of questions or requests for clarification. These questions will be compiled into email memorandums to be sent to DWM for DWM to provide answers to these questions. The included schedule assumes that DWM will provide system verification feedback within a 3 week review period.

2.2.4: GIS Data Management – DWM will be responsible for providing data cleanup for the GIS discrepancies documented to DWM, as noted in the previous sections, so as to create a GIS data set that is fully model ready that can and will be imported to the new base model. M&C will assist in this effort by providing the documentation of the discrepancies, attending 2 follow-up meetings with members of the DWM and GIS Department staff to review the requests and for providing a review of the completed effort of the GIS Department updates.

2.2.5: Facility Creation and Development - Model parameters for the major facilities (including but not limited to high service pumps, booster pumps, tanks, control valves) that exist in the current model will be documented in memorandum format to DWM. DWM is to confirm the properties and provide updates to any features that are not reflected properly for updating in the model. DWM shall also provide information for all new major facilities that are currently not in the existing models that need to be added including major facilities that are currently in the planning/design phase. The included schedule assumes that DWM will provide responses within 3 weeks regarding the major facilities.

Task 2.3: Detailed Hydraulic Model Development

2.3.1: Elevation Assignment – M&C will use software routines to automatically assign elevations to the model data from the USGS DTM and/or LIDAR. Model elevations will be subject to the elevation tolerance of the data used for the interpolation. Quality assurances such as model versus GIS contour comparisons will be performed following the software routine applications to ensure accuracies. Elevations for the finished water mains on the two water plant sites and other major elements such as pumps and tanks will be confirmed using record drawings.

2.3.2: Initial Pipeline Roughness Coefficient Assignments – As a starting point, M&C will assign pipeline roughness or "C-factors" based on the current factors established in the existing model. The original model development in 2002 included fifty (50) hydrant flow tests to better define pipeline roughness. For existing pipes added to the GIS database as part of the scope of work in Task 2.2, the C-factors will be based on pipe material (as available) and industry standards. A universal C-Factor of 100 will be assigned to all pipes that do not have pipe material information. Pipeline roughness coefficients may be adjusted in the model during the model calibration phase.

2.3.3: Pump Curves – M&C will assign pump curves to each of the current pumps. Pump curves already assigned in the model will be confirmed based on updated data provided by DWM. Data may include original manufacturer's curves or actual pump test data (tests performed by DWM). If pumps are operated on VFDs, the speed curves from the pump manufacturer will need to be provided by DWM as well. For pumps currently in the planning/design phase, the pump curves will be established based on the preliminary pump data. These pumps will be identified to be updated with the actual pump curves once the pumps have been installed.

2.3.4: Tank Configuration – The existing tank(s) shape/configuration will be checked and updated based on the data provided by DWM. For any tanks in the planning/design phases, a tank geometry will be included based on the preliminary data provided by DWM.

2.3.5: Model Control Logic Assignments – M&C will create model control logic to replicate current system conditions based on the available SCADA data, discussions with DWM operations staff and manually translating settings based on operator institutional knowledge. This task includes meeting with the operating staff to discuss typical system operations including pump control, speed control schemes for VFDs, typical tank level ranges, control valve settings, telemetry settings, etc. (estimated to be 3 meetings total).

Task 2.4: Existing Demand Development, Loading and Peaking

2.4.1: Evaluate Consumption and Production Data - This task will create an average day demand (ADD) loading dataset for the water system customers using meter billing data provided by DWM. McKim & Creed will analyze up to 3 years of meter data to calculate ADD values for the City's meters. As part of

the water audit process, the water meter billing data will be compared with available SCADA data from the Brown and Williams water treatment plants to determine the system ADD and to also determine peak demands for the system.

It is understood that the City's AMR data is available for all residential meters (approximately 81,000) and are geocoded. However, the commercial meters (larger than 1 ½-inch, approximately 8,000) have been converted to AMR meters are being geocoded. Furthermore, the billing records reflect the billing address and may not contain a physical address which would be needed to geocode the meter locations. It is understood that DWM has GPS information on approximately 800 of the commercial meters from record drawing information provided through recent replacement projects and these 800 meters have been geocoded. Accordingly, the customer billing department is currently working to physically locate all remaining commercial meters. It is understood that this effort will be complete by the end of 2015; therefore, M&C anticipates that the City will provide all meter accounts geocoded in a GIS format. These commercial accounts will then be added to the GIS database utilizing this information. Also, M&C will review the data provided from the CDM Smith TM for the top 20 commercial users and compare to the current water billing data to develop a more current list of the top 20 commercial users.

2.4.2: Develop Diurnal Curve – M&C will also analyze SCADA data or historical data to generate a system-wide diurnal demand pattern to apply to the model demands for creating an extended period simulation (EPS) model. This diurnal curve will be compared to the system-wide diurnal curve developed for the existing model.

2.4.3: Demand Import - Demands will be assigned in the model using automated import routines, like the Load Builder tool in WaterGEMS, which can assign the geocoded meter demands to the closest model pipe or node. The demands developed in Task 2.4.1 for the top 20 commercial users will be point loaded into the model individually by assigning the demands directly to a node located at each of the meter locations.

Task 2.5: Hydraulic Model Calibration

The most important step to model calibration is the initial model set up. The more accurate the detail contained in the model makes the model closer to reality which will result in less calibration effort. The first step in calibration is the

model construction that has been identified in Task 2.1 through Task 2.4. Detailed model construction data, accurate demand distribution, and precise operational controls will reduce the amount of model manipulation and field testing required for calibration.

2.5.1: Existing Fire Flow Data – M&C will perform an initial calibration check utilizing existing fire flow data and static pressure information provided by DWM. Existing fire flow data and static pressures are available through Public Works from the CityWorks database. DWM will export shapefiles from GIS to provide the information to M&C. This information will be used as a starting point for reviewing initial model results. A broad calibration will include the initial C-factors from the original model, the operational data from DWM staff, the geocoded demand distribution and the detailed model construction along with the fire flow test data. The fire flow data will be compared to initial model results to identify areas of general disagreement. This information will be used to confirm broad calibration items such as inaccurate elevation data, major pipeline discontinuities, and operational controls.

2.5.2: Pump Characteristics - If current information regarding the existing pump curves, impeller sizes, and/or historical operations of the pump is found to be unavailable during the model construction task or seemingly not accurate based on the initial model results, then a pump performance test will be performed to confirm the pump operations. Pump performance testing will be performed by the DWM staff with a representative from McKim & Creed present to document results. Pump performance testing will include the operation of one (or more) pump(s) at a pump station to document discharge flow and pressure under various operating conditions. It is anticipated that performance testing will be required for the Godwin Booster Station and the Finley Booster Station. **It is assumed that three (3) such field tests are to be performed.**

2.5.3: Operational Data – As noted in Task 2.3.5, M&C will set the initial operational control based on data and information gathered from the DWM operations staff for pumps, control valves, and elevated water storage tanks in the water system. Additionally as a part of McKim & Creed's current SCADA contract, M&C will investigate the availability of historical trend data for the city's major water system features including elevated water storage tanks, booster pumping stations, and the high service pumps at both water plants. If SCADA data is available, the operational controls can be confirmed through the historical trend analysis. If SCADA data or historical data is unavailable, field

data can be obtained by installing pressure recorders at the major features to capture current operating tank levels, HGL data for the water plants, and the suction and discharge pressures for booster pumping stations as may be needed. **If any field verification is required, this effort will be paid for in accordance with the allowance funding.**

2.5.4: Hydraulic Grade Line Calibration - Existing historical pressure recorded data is not available, M&C will install 15 portable field-installed wireless hydrant pressure recorders (HPR) to simultaneously supply pressure data in each HPR area in order to assist with hydraulic grade line calibration. The field pressure data for each point will be recorded for approximately one (1) week to compare to model results for that location. M&C will GPS each HPR location to determine location and vertical data to provide for a more accurate calibration. During the week of installation, hydrant flow testing may also be performed at the same time within the HPR areas by M&C to provide additional 'strain' on the system increasing pipeline velocities and allowing the pressure recorders to capture each of the flow events. It is anticipated that five (5) HPR areas of the existing distribution system will require additional pressure data.

During the period of time that the hydrant pressures are being recorded, it will be important that DWM is collecting key operational information such as tank levels, pump status, control valve operation, etc. It is assumed that this information can be obtained from the SCADA system historical data or DWM can provide this information from paper data.

The hydraulic grade line information that is derived from the hydrant pressure recorders will be compared with extended period results from the hydraulic model to determine calibration. The HGL trends will be plotted together and the calibration goal is to achieve similar rising and falling trends in the HGL at the same location with the same magnitude of elevation. Large drops in the HGL along a pipeline can help identify closed valves. HGL profiles with varying slopes when comparing field data vs. model results indicate areas with different C-factors, incorrect pipe diameters, and/or inaccurate flows in the model. The HGLs mapped graphically across the distribution system will also provide information regarding the path of flow through the system.

If the data being collected is indicating unexpected results that would tend to indicate a closed value situation or erroneous results, the data collection will be stopped as soon as practical. If the data seems to indicate closed valves, M&C

will document this information to DWM to assist them in determining the location of the closed valve(s). If the closed valve(s) are located and opened, it is anticipated that new pressure data will need to be collected. **It is assumed that two (2) of the five (5) HPR areas will require the collection of new pressure data. If more than two (2) HPR areas require the collection of new pressure data, this additional effort will be paid for in accordance with the allowance funding.**

At the completion of the Hydraulic Grade Line Calibration task, the fifteen (15) hydrant pressure recorders will be turned over to DWM to become the property of the City.

2.5.5: SCADA Data Comparison – After the model HGL information is verified through the new HPR data, the extended period model will also be calibrated through model vs. SCADA comparison. The average day demands and max day demands determined from the SCADA system will be incorporated into the model to create two extended period scenarios. The 24-hr trend data from the tanks, pumping stations and other keys points in the water system model will be overlaid with the relative SCADA data from matching demand periods. Trending comparisons which do not match closely will be used to trouble shoot the model and provide for further calibration. Areas of the model that cannot calibrate well based on SCADA data will be addressed with the DWM in the initial modeling workshop and may require additional field calibration (such as hydrant flow testing).

2.5.6: Pipeline C-Factor - The initial model calibration scenarios will incorporate the pipeline C-factors as noted in Task 2.3.2. Following initial calibrations based on existing hydrant flow data, pump testing and adjustments in operational data should areas of the model disagree with field data, than additional C-factor testing may be implemented. C-factor testing will utilize hydrant flow testing means between fire hydrants on selected pipe segments to ascertain a more accurate evaluation of the pipeline roughness. M&C will perform the hydrant flow testing and document the results. **Prior to initiating the testing, door hangers shall be distributed by DWM staff to notify the residents of the testing.** Areas of the city that contain unlined cast iron pipe may require extensive C-factor testing. It is assumed that fifty (50) hydrant flow tests will be required to better determine pipeline roughness. **Due to the uncertainty of C-factor testing actually required, an allowance has been indicated in the**

contract for additional testing beyond the initial fifty (50) tests. The additional C-factor testing allowance will only be utilized with approval from DWM.

2.6: New Model Verification and QA/QC

At the completion of updating the GIS data, construction of the base model, updating geocoded demands and calibration procedures, the outcome will have created a new model of the existing water distribution system. The new model will be subject to QA/QC and verification with DWM staff.

2.6.1: QA/QC - Prior to and during the calibration process, a detailed QA/QC process will be provided to review the GIS revisions made to the GIS data, the updated geocoded water demands and the new HPR data. It will also include an internal model review of both the steady state and extended period simulation (EPS) scenarios and output data to verify accuracy with historical data.

2.6.2: Verification/Interactive Modeling Workshops – To complete the QA/QC process, M&C will conduct two (2) interactive modeling workshops with DWM staff for final verification of the new model.

M&C will meet with key staff and operators to provide a live demonstration of the new model of the existing distribution system. The workshop will include demonstrations of steady state and EPS scenarios along with model comparisons to SCADA data and field measure data. Model results will be presented graphically and through animations to help staff visualize pressures, flows, and pump operations and tank levels throughout a typical day. The initial meeting will allow feedback from the staff on the existing system, identifying results from the model which may not reflect what is expected and assist in identifying potential problem areas in the existing water system.

Upon completion of the initial interactive workshop and addressing comments received from DWM during the initial modeling workshop, M&C will then provide a final modeling demonstration with DWM for final verification of the new baseline model. The final demonstration will again include model animation of results to visually indicate the typical daily operations of the water system.

Task 2.7: Water Quality (Age) Modeling

Following the creation of the new water distribution system model and after the calibration is complete; M&C will develop a modeling scenario to evaluate the water system age for the existing average day demands. Residence times in the distribution system are a critical factor influencing water quality. The water age analysis will help to identify areas of the system with extended residence times that may contribute to poor water quality. It will also provide an evaluation of the turnover rate for water within the city's water storage tanks.

The water age results will be compared with water quality sampling information throughout the water system as provided by DWM. The data provided by DWM will include sample levels, collection dates, and collection locations. DWM has manual routine flushing procedures and automatic flushers. This data will also be provided to M&C to assist with the evaluation of water age. Water sample data will be compared to water age results from the model to correlate age with water quality. Areas of the existing water system with extended water age which correlate with poor water quality sampling data provided by DWM will be addressed with DWM during the interactive modeling workshops. M&C will attempt to determine a correlation between water age in the existing system model and data results to develop a "maximum" water age for water quality modeling. This information will be utilized to evaluate future water system improvements that are recommended for the capital improvement plan to attempt to reduce water age problem areas. If a maximum water age time is not established from the existing system model then the future system improvements will be evaluated based on a maximum water age of 3 to 5 days based on typical industry standards.

Task 2.8: Water Hammer/Transient Modeling

Following the creation of the new water distribution system model and after the calibration is complete; M&C will provide for transient modeling of the new pump and transmission main from the Brown WTP to the Williams WTP. The transient model will be isolated to only evaluate the 24" diameter finished water transmission main. DWM will provide record drawings for the existing pipeline to include the pipe material, pressure class, elevations, size and locations of air release and/or combination air/vacuum valves along the pipe alignment.

Information for the new pumps including certified pump curves shall also be provided.

Transient modeling results will be presented graphically to DWM during a preliminary review meeting. Final results will be presented in the hydraulic model development technical memorandum.

Task 2.9: Technical Memorandum

McKim & Creed will document the methods used for model creation, development, and calibration in a Technical Memorandum. This report will also include a summary of the GIS updates, existing water demands, diurnal curve, a summary of assumptions, a summary of hydrant flow data, the HGL calibration results, pipeline C-factor testing and updates, SCADA calibration comparisons, model update procedures, and model version control strategies.

McKim & Creed will provide five (5) printed copies in draft format of the Technical Memorandum and exhibits for DWM review. It is assumed DWM will take approximately four (4) weeks to review the draft and provide comments. McKim & Creed will schedule a review meeting with DWM to review the comments. Upon completion of the review meeting, McKim & Creed will finalize the technical memorandum and provide five (5) printed copies and one (1) electronic copy on CD.

Item 3: Water Audit and Water Loss Control Program

The program will start with an AWWA M36 water audit and water loss analysis, to identify and validate the current levels of loss and how those relate to the economically optimal levels of loss. This begins with a top down effort – which means using available records and data – but to be effective there has to be more detailed bottom up analysis and validation, which normally involves hydraulic flow testing of the supply meters, some field testing of customer meters, targeted pressure/flow measurements for leakage/pressure management, and billing data analytics. At the completion of the water audit (top-down analysis) and validation (bottom-up analysis), a Water Loss Program Design will be developed

with recommendations for the management of the water loss program which will include a recommended implementation plan for leak and pressure management of the City's water distribution system.

Task 3.1: Discovery and AWWA M36 Water Audit

The team will perform the following tasks in order to prepare and provide the AWWA M36 Water Audit.

Task 3.1.1: Discovery -

- Complete the compilation and review of pertinent records regarding water production, consumption, billing, finance and distribution and storage operations.
- Conduct interviews with pertinent staff regarding same.
- Conduct site visits for pertinent facilities regarding same.

Task 3.1.2: AWWA M 36 Audit Top-Down Analysis -

- Synthesize records and water system data into AWWA M36 Standard Water Audit format.
- Calculation of water balance inputs from detailed data discovery
- Top-down validation of detailed input calculations:
    - Basic Lag-Time Adjustments on Annual Consumption Data
    - Master Meter Error Adjustment
    - Composite Customer Metering Inaccuracies
    - Average System Operating Pressure
    - Composite Customer Retail Unit Cost
    - Variable Production Cost
- Development of Data Validity Scoring
    - Staff interviews regarding operational and data management practices
    - Assessment of data confidence grades for all Water Audit inputs
    - Determination of global Data Validity Score

Task 3.1.3: Calculation of Key Performance Indicators -

- Non-Revenue Water by Volume – Total, Normalized;
- Non-Revenue Water by Value – Total, Normalized, % of Operating Cost;
- Total Water Losses by Volume – Total, Normalized;

- Unbilled Authorized Consumption by Volume - Total;
- Apparent Losses by Volume – Total, Normalized;
- Real Losses by Volume – Total, Normalized;
- Infrastructure Leakage Index;
- Water Audit Data Validity Score.

Task 3.1.4: Technical Memorandum

A technical memorandum will be prepared to document what information was evaluated including water loss performance metrics in units of volumes, values (costs) and validity, and the metrics to dictate focus areas for the Water Loss Control Program.

Five (5) printed copies in draft format of the Technical Memorandum and the M36 Water Audit will be provided for DWM review. It is assumed DWM will take approximately four (4) weeks to review the draft and provide comments. A review meeting will be scheduled with DWM to review comments. Upon completion of the review meeting, the technical memorandum and M36 Water Audit will be finalized with five (5) printed copies and one (1) electronic copy on CD provided to DWM.

Task 3.2: Validation and Program Design

The team will perform the following tasks for the validation (bottom-up analysis) and to develop the Water Loss Program Design.

Task 3.2.1: Detailed flowcharting of existing business processes from meter reading to customer billing (read-to-bill).

Task 3.2.2: Coordination with Billing staff to extract detailed historical customer consumption database(s).

Task 3.2.3: Advanced billing analytics of historical customer consumption database for:

- Development of customer consumption profile for use in composite retail rate calculation;
- Development of customer meter profile for use in WLC Program recommendations;

- Development of consumption profiles to identify trends, anomalies and areas of concern;
- Validation of consumption totals by account, customer class, rate code, and monthly global totals;
- Analysis of largest accounts, inactive accounts, and unbilled accounts;
- Screening of database to develop target accounts list for meter right-sizing analysis.

Task 3.2.4: Coordination with Operations staff to extract detailed historical production meter flow verification data from DWM's paper data spreadsheets.

Task 3.2.5: Perform in-field hydraulic flow verification tests for each of the City's five (5) finished water meter sites.

- It is understood that some finished water meter sites have existing test taps. Cavanaugh will perform inspection of any existing taps for verification of suitability, and recommend to the DWM if tap modifications or new tap installations will be necessary for flow verification tests to be conducted.
- It is assumed that any taps needed will be installed by DWM.

Task 3.2.6: Provide detailed analysis of production meter data:

- Validation of production totals;
- Identification of trends, anomalies and areas of concern;
- Develop for WLC Program recommendations.

Task 3.2.7: Coordination with metering staff for acquisition of large and small meter test database(s).

Task 3.2.8: Perform targeted sample customer meter testing in residential and non-residential meter populations. The final exact quantity and selection of meters for testing will be determined during the validation phase. For scoping purposes, the testing quantity is assumed to be 100 residential meters and 20 non-residential meters.

Task 3.2.9: Provide detailed analysis of targeted sample testing:

- Support of Composite Customer Metering Inaccuracies calculation;
- Use in WLC component mapping and economic target setting;
- Develop for WLC Program recommendations for residential and non-residential meter testing & remediation optimization.

Task 3.2.10: Pressure optimization analysis within existing distribution system single pressure zone.

- Targeted field data collection of pressures and flows to validate:
  - Infrastructure condition factor
  - Pressure optimization potential
- Analysis for leakage reductions, break reductions, improved customer service, energy cost reductions, extension of asset life, incorporating internationally proven pressure management strategies.

Task 3.2.11: Development of WLC component mapping and economic analysis for optimized target setting.

- Unbilled Consumption components;
- Apparent Loss components;
- Real Loss components;
- Aggregated WLC economic target setting – identify the optimal levels of water loss for the City of Durham in near-term and long-term planning horizon;

Task 3.2.12: Water Loss Program Design

- Design of near- and long-term WLC Program recommendations for the management and reduction of non-revenue water, and improvements in system efficiency benchmarking and data validity;
- Evaluation of existing demand management program, and gap analysis for long-term conservation objectives;

- Incorporation of long-term water loss management (supply side conservation) objectives into hydraulic model demand forecasting;

- Development of WLC Program implementation plan, with prioritization and benefit/cost estimations.

Task 3.2.13: Water Loss Program Document

The Water Loss Program Document will be prepared to document what information was evaluated, how it was evaluated, development of pressure optimization, development of economic analysis, recommendations, and prioritization.

Five (5) printed copies in draft format of the Water Loss Program Document will be provided for DWM review. It is assumed DWM will take approximately four (4) weeks to review the draft and provide comments. McKim & Creed will schedule a review meeting with DWM to review the comments. Upon completion of the review meeting, the Water Loss Program Document will be finalized with five (5) printed copies and one (1) electronic copy on CD provided to DWM.

If DWM requests assistance with the implementation of the Water Loss Control Program, this effort will be added to the contract by a contract amendment.

Item 4: Development of Future Water Demand Projections

Task 4.1: Existing Water Demands

The existing water demands, average daily demands, peak day, peak hour and system-wide diurnal demand pattern will be determine as indicated in Task 2.4 and Task 3.2. The existing water demands will be stratified into categories or types of use as needed. This information will become the baseline for developing the future water demand projections.

Task 4.2: Future Water Demand Projections

The DWM has established a 25-year planning period for evaluation of future water demands. Based on discussions with DWM staff, it was decided not to

utilize the population projections developed as part of the recently completed Wastewater Master Plan. Instead, M&C will develop population and employment projections based on the CAMPO 2040 Long Range Transportation Plan (LRTP).

The LRTP will be utilized to stratify the City of Durham's Service Area into the appropriate Transportation Analysis Zones (TAZ) in order to assign the population and employment projections within the service area. These future demand projections will be uniformly distributed along the distribution system within the TAZ. These projections will be developed in 5-year windows for the 25-year planning period.

The following reports and technical memorandums (TM) will be reviewed and if appropriate the flow projections and/or population projections will be incorporated into the appropriate TAZ.

- Southeast Region Growth Area TM
- Research Triangle Park Foundation Study
- Duke University Study
- CDM Smith TM for top 20 Water Users (to be developed with the RCW Master Plan)

Even though the Jordon Lake Partnership (JLP) report prepared by CDM Smith is to be considered outside the planning period and scope of this report, DWM requested that the flow projections developed in this study based on the TAZ data be compared to the flow projections in the JLP. If there seems to be significant differences, M&C will bring to the attention of DWM for discussion and additional evaluation. Any additional evaluation due to the differences between the TAZ data and the JLP requested by DWM will be considered additional services.

Task 4.3: Reclaimed Water Usage

The City of Durham currently does not have a reclaimed water (RCW) distribution system. However as part of the City's strategy for wastewater master planning, the City is considering the possibility of implementing a RCW distribution system. A preliminary, high-altitude, evaluation was provided as

part of the wastewater master planning effort. The DWM is currently planning to develop a more detailed RCW master plan. However, this information will not be available for consideration for the Water Model Update. It is understood that as a RCW system is developed it will have an impact of the potable water demands as irrigation and some industrial demands would be replaced with RCW.

For this study, the following reports are to be reviewed for possible RCW demands and as appropriate utilized in the evaluation of future potable water demand projections.

- Duke University Study
- Research Triangle Park Foundation Study
- CDM Smith TM for top 20 Water Users (to be developed with the RCW Master Plan)

Task 4.4: Interlocal Agreements

The City currently has five (5) interlocal agreements with local governmental entities for providing bulk water either under normal usage and/or on an emergency basis. It is understood that the North Expansion will include another interconnect with the City of Raleigh. The five (5) current agreements are as follow:

- Town of Cary dated March 31, 2009
- Town of Hillsborough dated March 4, 2004
- Orange County
- Orange Water & Sewer Authority dated December 14, 2009
- City of Raleigh

It is also understood that the Jordon Lake Partnership (JLP) coalition is evaluating and determining how best to utilize the raw water resources of Jordon Lake. The potential is a new finished water facility located in the vicinity of

Jordon Lake that provides a new potable water source into the City's distribution system. **However for the purpose of this study, the JLP is to be considered outside of the 25-year planning period.**

The requirements of the interlocal agreements will be reviewed and incorporated into the model as projected water demands or flow/pressure sources. These entries/values may vary depending on the terms of the agreement, the planning year and/or the model scenario.

Task 4.5: Technical Memorandum

A technical memorandum will be prepared to document the information evaluated, the process for developing the population projections, evaluation of the various reports, impact of RCW usage and the five (5) 5-year water demand projections for the 25-year planning period.

M&C will provide five (5) printed copies in draft format of the Technical Memorandum for DWM review. It is assumed DWM will take approximately four (4) weeks to review the draft and provide comments. McKim & Creed will schedule a review meeting with DWM to review the comments. Upon completion of the review meeting, the technical memorandum will be finalized with five (5) printed copies and one (1) electronic copy on CD provided to DWM.

Item 5: Development of Capital Improvement Plan

As part of the water model update, DWM desires to determine and develop a Capital Improvement Plan (CIP) for the 25-year planning period ending in year 2040. The CIP will be developed in five (5), 5-year periods and will be based on the future water demand projections and the recommendations from the Water Loss Program evaluation. Based on this information, various modeling scenarios will be developed and run to determine the needed system improvements. M&C will utilize the average day demand, peak day and peak hour demands as well as the system diurnal curve developed under Task 2.4.

The City's "Reference Guide for Development "(revision dated December 2014) and the following industry standards will also be utilized as a guideline in the development of the project improvements for the CIP;

- Minimum system pressure of 40 psi at demand nodes for average day demands.
- Minimum system pressure of 20 psi at demand nodes for peak day demands with fire flow.
- Maximum system pressure of 90 psi at demand nodes. (M&C to document areas that exceed the 90 psi in the high pressure zone(s) to indicate need for PRVs.)_
- Maximum pipe velocity (depending on location and pipe age) not to exceed 8 fps.

The model operational conditions that will serve as the basis for the model scenarios developed and evaluated are summarized below:

- Minimum Day demand conditions will be used to determine pump station and transmission main improvements when filling tanks. The Minimum Day demand factor will extracted from the diurnal curve information developed in Task 2.4.

- Maximum Day demand conditions will be used to determine pump station and transmission main improvements needed to supply customer demand utilizing production alone (no storage).

- Peak Hour demand conditions will be used to determine pump station and transmission main improvements during times of peak water use to include utilizing water storage. The Peak Hour peaking factor developed in Task 2.4 will be utilized.

- Water system storage capacity will be evaluated based on the current DWM guidelines. If no guidelines exist then M&C will assist DWM to establish criteria for evaluating system storage based on industry standards. (e.g.- Total storage capacity is equal to operational storage capacity of 50% of average daily demand plus fire flow storage).

- Water system storage capacity will also be evaluated for each pressure zone in comparison with the projected water system demands. The storage capacity will be planned to maximize

capacity under average daily demand conditions and optimize the City's ISO rating for minimum storage requirements under fire flow conditions.

- Fire flows will be evaluated using the criteria provided in the City's "Reference Guide for Development" based on the allowable development type from the City's zoning. DWM will confirm and agree to the fire flows and durations to be utilized.

Even with the use of the City's guidelines and industry standards there may be items that are exceptions that will need to be considered as part of the model scenarios like reasonable fire flows, water age, etc.

Task 5.1: Analysis of Current System Needs

An analysis will be provided using the updated model to determine existing system needs that might exist to meet current flow demands, current water quality needs, requirements of the five (5) interlocal agreements identified in Task 4.4 and fire flow demands while maintaining the noted guidelines. The evaluation will also focus on the following:

- Incorporating the new 615 pressure zone
- NC Central campus area
- Treyburn area
- OWASA interconnection (Note that DWM is currently performing field testing of this interconnection and will provide the results to M&C)

Model scenarios will be run for the average day demands, max day and peak hour and various fire flow scenarios to determine the existing system improvements.

A workshop will be provided to present the information determined for the existing system needs. The existing system improvement recommendations and acceptance will be documented in a technical memorandum as this information

will be needed in order to proceed with the development of the planning scenarios in Task 5.2.

Task 5.2: Planning Scenario Modeling for Future Conditions and Needs

The future system improvements will be developed based on the future water demands developed in Task 4.2 for the five (5), five-year planning periods. Model scenarios will be run for the average day demands, max day and peak hour and various fire flow scenarios while taking into account the existing system needs identified in Task 5.1. These scenarios will also address the requirements of the five (5) interlocal agreements identified in Task 4.4. The model scenarios will be developed meeting the noted industrial standards to determine the future system improvements. Additional model scenarios will be developed to address adjustments to water demands based on possible RCW impacts developed in Task 4.3.

A workshop will be provided to present the information determined for the planning scenario modeling. The future system improvement recommendations and acceptance will be documented in a technical memorandum.

Task 5.3: Other Drivers and Prioritization

Task 5.3.1: Other Drivers - There are other drivers that will need to be taken into consideration and incorporated into the evaluation of the CIP. These drivers include the following:

- Identifying critical users
- Identifying critical components of the system
- Age and replacement needs of components
- Potential regulatory requirements
- Other drivers as determined/provided by DWM

It is understood that the DWM has had a criticality assessment performed for the City's infrastructure. M&C will review the recommendations with DWM to determine what components of the criticality assessment that DWM will want to

include as part of the CIP evaluation. M&C will also meet with key staff members for input on the following drivers:

- Critical users of the water system like hospitals, emergency response, and major users, etc.
- Critical components in need of replacement due to age, maintenance/historical operational issues and/or capacity deficiencies.
- Potential regulatory items to determine the need to address.

Task 5.3.2: Prioritization - To assist with prioritization of the identified projects a weighting system will be developed and weighting factors assigned to each of the prioritization factors. Each of the identified projects will then be assessed to determine which and how many of the prioritization factors would be assigned to each project. This process will help DWM to prioritize the projects. The typical prioritization factors utilized are as follow:

- Growth/Population/Service Areas
- Critical Users
- Critical Components/Criticality Assessment
- Aging components/maintenance needs
- Special Areas/Assessments
- Regulatory Requirements
- Other prioritization factors as determined/provided by DWM

Task 5.3.3: Project Cost Development - A level of magnitude construction cost opinion will be developed for each of the recommended projects. A project cost will be developed to include an estimate for basic engineering services and the construction contingency. With the results of the prioritization and development of the project cost, the 5-year increments of the 25-year CIP can be developed.

Task 5.3.4: Financial Evaluation - It is understood that Raftelis Financial Consultants (RFC) currently provides DWM financial assistance with rate structures, rate evaluations, etc. M&C will coordinate and provide the results of

the CIP evaluation to RFC for their use in reviewing the impacts on the funding for the proposed projects. The outcome of their evaluation will be utilized to finalize the CIP recommendations.

Task 5.4: Technical Memorandum

A technical memorandum will be prepared to document the various modeling scenarios, the evaluation for the recommended system improvement needs, the prioritization method, development of project cost opinions and five (5) 5-year CIP for the 25-year planning period.

M&C will provide five (5) printed copies in draft format of the Technical Memorandum for DWM review. It is assumed DWM will take approximately four (4) weeks to review the draft and provide comments. McKim & Creed will schedule a review meeting with DWM to review the comments.

Upon completion of the review meeting, the technical memorandum will be finalized with five (5) printed copies and one (1) electronic copy on CD provided to DWM.

Item 6: Deliverables, Training and Support

Task 6.1: Deliverables

Task 6.1.1 Documents - At the completion of Item 5, the final approved technical memorandums will be compiled into three final documents:

- Final Hydraulic Model Update with Animation Tool
- Final Water Audit and Water Loss Program
- Recommended 25-year Capital Improvement Plan

Five (5) printed copies and one (1) electronic copy on CD will be provided to DWM.

The 25-year Capital Improvement Plan will be presented as a final recommendation and may be adjusted by DWM for final acceptance and adoption by the City Council. If DWM requires M&C to assist in modifications

or adjustments to the submitted recommended capital improvement plan, this additional effort will be paid for in accordance with the allowance funding.

Task 6.1.2: Animation Software – M&C has developed software that provides for a visual animation of the output data from the results of hydraulic model runs (scenarios). This software is referred to as the Hydraulic Model Animation Tool. M&C agrees to grant the City a license to use the software provided the City executes the attached License Agreement.

Task 6.1.3: Presentation - M&C will prepare a PowerPoint presentation of the completed updated model explaining the process, existing water demands, future water demand projections, modeling scenarios and the 25-year CIP recommendations.

One presentation will be provided to the DWM staff and a final presentation will be provided for the City Council and Manager.

Task 6.2: Model Training Workshops

Task 6.2.1: Initial Model Training Workshop - M&C will provide two (2) days of an on-site workshop and instruction on the features and capabilities of the updated model. The training will also include using the Hydraulic Model Animation Tool demonstrating how to extract model output data from a model scenario and inputting the data into the animation tool to create the model animations. Additionally, the training will include instructions on how to setup the simulation properties (i.e. pressures, flow, velocities, etc.) and attributes (color, width, etc.) in order to receive the output displays in a particular manner within the limitations of the animation software.

The workshop will be held at the DWM's facilities and will include transfer of model files, set up and testing of the model on the DWM's computer(s).

Task 6.2.2: Follow Up Model Training Workshop – M&C will provide one (1) additional on-site training workshop on the use of the model and Hydraulic Model Animation Tool approximately three (3) months after the initial training workshops. This will include the creation of animation scenarios of two (2) additional model results created by the DWM's staff.

This additional training workshop is intended to assist with the understanding of the hydraulic model, animation tool and the animation process. It is not intended to provide for the updating of the water model nor the creation of new model scenarios.

Task 6.3: Annual Updates

On an annual basis, M&C will review the GIS updates provided by the GIS Department to confirm the data for being model ready. This would include the following:

- Pipelines – geometry, pipeline diameter, material.
- Storage Tanks – location, tank geometry, capacity, elevations, operating ranges, controls.
- Pumps – location, pump capacity and head, make/model. Pump curve is also required for updates.
- Control Valves – location, type, make/model with operational conditions.

M&C will also meet with DWM staff to update model controls to reflect changes to the normal operating procedures of the system. This may include pump controls, water tank levels, etc.

M&C will provide a Technical Memorandum identifying the items that have been updated on an annual basis.

Item 7: Project Allowance Scope Items

The following project allowance scope items are provided in the event additional testing and verifications are required in excess of the quantities identified in the scope of work:

- Additional pump performance testing - Item 2.5.2 indicates that three (3) individual pump performance tests are included in the base scope. Additional tests shall be paid for in accordance with the project allowance.

- Field verification of existing operational data- Item 2.5.3 indicates that existing operational data for major components of the system is available. If field verification is required, this effort shall be paid for in accordance with the project allowance.
- Additional hydraulic grade line (HGL) verification. Item 2.5.4 indicates that five (5) HPR areas and two (2) HPR retest areas are included in the base scope. Additional areas or additional retest areas shall be paid for in accordance with the project allowance.
- Additional hydraulic flow testing – Item 2.5.6 indicates that 50 hydrant flow tests are included in the base scope. Additional tests shall be paid for in accordance with the project allowance.
- Additional in-field hydraulic flow verification tests for City's finished water meters – Item 3.2.5 indicates in-field hydraulic flow verification for five (5) finished water meters are included in the base scope. Additional tests shall be paid for in accordance with the project allowance.
- Additional customer meter testing for residential and non-residential meters – Item 3.2.8 indicates that 100 residential and 20 non-residential meters are included in the base scope. Additional tests shall be paid for in accordance with the project allowance.
- Capital Improvement Plan – Item 6.1.1 indicates that a recommended 25-year capital improvement plan will be submitted as part of the final deliverable documentation. If DWM requires M&C to assist in modifications or adjustments to the submitted recommended capital improvement plan, this additional effort will be paid for in accordance with the project allowance.

Item 8: As Needed Modeling Support Services

Task 8.1: As-Needed Operational Modeling Support – As requested, M&C will provide modeling support to DWM to perform operational modeling scenarios, future modeling scenarios, fire flow modeling, water quality modeling, and other 'what-if' modeling scenarios to further help support water system growth and planning.

Task 8.2: Third Party Modeling Inquiries - M&C will provide modeling support to DWM for evaluating third party inquiries for pressure, pipe sizing and fire flows that are requested for new demands or developments on the existing system or expansions of the existing system to support new development.

Item 9: Additional Services

The following items are currently outside the scope of work, but can be provided by written amendment with the City and McKim & Creed should they become necessary:

- **Hydraulic Model Updates** – Providing for additional updates to the model after development of the new model as outlined in the scope of work.

- **Scenario Creation**- Providing for the creation of additional water model scenarios for new demands, fire flows, new additions, water quality and other "what if" modeling scenarios after development of the new model as outlined in the scope of work.

- **Water Quality Evaluation** – Providing for additional water quality model scenarios after development of the new model as outlined in the scope of work.

- **Water Hammer/Transient Modeling** – Providing for additional water hammer/transient modeling to assist with modeling and selecting appropriate control valves or operational modifications to minimize the effects of water hammer on the finished water system then the water hammer modeling outlined in the scope of work.

- **Rate Evaluation/Rate Studies/Funding Evaluations -** Providing for rate studies, funding evaluations and recommendations for adjustments in the rate structures for the funding and financing of the CIP program.

- Water Loss Program Implementation - Providing assistance with the actual implementation of elements of the Water Loss Program after the program has been finalized and accepted by DWM.

Project Schedule

The project schedule shall be as follows:

Item 2 - Hydraulic Model Development	**Duration**
Collect Data/Review	10 wks*
GIS Data Review	6 wks
GIS Update by City	6 wks
Hydraulic Model Construction	18 wks*
Evaluation & HPR Calibration	12 wks
Hydrant Flow Testing	4 wks
Completion of Updated Model	4 wks
Interactive Modeling Workshops (2)	4 wks
Water Quality/Transient Modeling	8 wks
DWM TM Review	4 wks
Final TM Submittal	2 wks
Subtotal Item 2	**78 wks Total (48 wks from NTP)**

Item 3 - Water Audit & Water Loss Program	**Duration**
Prepare Draft AWWA M36 Audit	9 wks*
DWM TM Review	4 wks
Development of Water Loss Control Program	14 wks*
DWM Review of Water Loss Control Program	4 wks
Final Water Loss Control Program Submittal	4 wks
Subtotal Item 3	**35 wks Total (48 wks from NTP)**

Items 4 & 5- Water Demand Projections & CIP	**Duration**
Water Demand Projections	12 wks
DWM Water Demand TM Review	4 wks
Final Water Demand TM Submittal	4 wks
Analysis of Current System Needs	4 wks

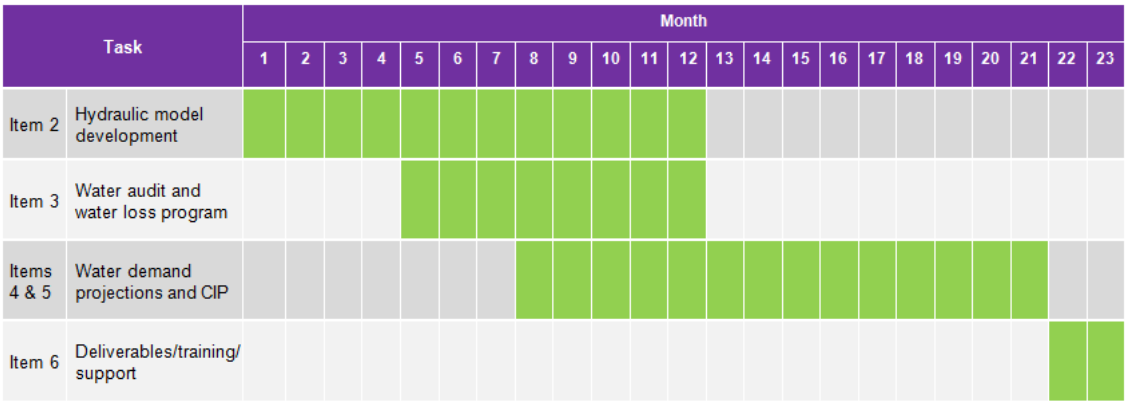
Current System Need Modeling Workshop	1 wk
DWM TM Review	4 wks
Final Current System Needs TM Submittal	2 wks
Analysis of Future Planning System Needs	8 wks
Future System Needs Modeling Workshop	1 wks
DWM TM Review	4 wks
Final Future System Needs TM Submittal	2 wks
Project Prioritization	4 wks
Cost Opinion Development	4 wks
Rate Evaluation by Others	2 wks
DWM CIP TM Review	4 wks
Final CIP TM Submittal	2 wks
Subtotal Items 4 & 5	**62 wks Total (38 wks from Completion of Item 2)**

Item 6 - Deliverables/Training/Support	**Duration**
Document Submittal	7 wks
Model Training	1 wk
Follow-up Training	**
Subtotal Item 6	**8 wks Total (8 wks from Completion of Items 4&5)**

TOTAL PROJECT SCHEDULE	**94 wks from NTP**

* Assumes DWM provides requested data within 4 weeks of request.
** Schedule to be determined.

The following Gantt chart summarizes the previous detailed task schedule:



City's Responsibilities

The following items shall be considered the responsibility of the City:

- DWM shall select one person as the key point of contact for the project.
- Review engineering documents submitted by Engineer and providing review comments and/or markups. DWM must perform these tasks within the timeframes identified in the scope of work in order to maintain the schedule as presented.
- Provide existing data and model information to include GIS data, pump curves, tank elevations and water consumption records (with links to GIS meter locations).
- Provide clarifications for piping connectivity and discrepancies between GIS data and model data.
- Provide model parameters for all major system facilities for high service pumps, booster pump stations, tanks and control valves that will include current operating controls.
- Provide access to existing SCADA and historical information.
- Wireless hydrant pressure recorders (HPR) are being provided for remotely recording of pressure information/data. The City will provide and pay the

monthly Verizon service for these recorders from the City's current Verizon account.

- Provide actual pump testing verification to assist in calibration of the existing model.

- DWM is to provide, or provide for the purchase/cost of, the unlimited pipe version of the WaterGEMS model software (current version) and basic training on the use of the software as may be needed. It is understood at this time that DWM has the software loaded on the City's computers and has staff already trained and knowledgeable in the use of the software.

- Providing for rate evaluations, funding evaluations and financial management of the CIP program.

Compensation

The City agrees to pay the Engineer as compensation for their services as follows:

Item 1: Project Management and Coordination	$ 99,600 Lump Sum
Item 2: Hydraulic Model Development	$244,300 Lump Sum
Item 3: Water Audit and Water Loss Control Program	$190,300 Lump Sum
Item 4: Development of Water Demand Projections	$ 23,300 Lump Sum
Item 5: Development of Capital Improvement Plan	$142,300 Lump Sum
Item 6: Deliverables, Training and Support 6.1 and 6.2	$ 46,200 Lump Sum
TOTAL LUMP SUM	**$746,000**

Item 6.3 Annual Updates	$ 11,500 Hourly/Year
Item 7: Allowances	$118,000 Hourly
Item 8: As Needed Modeling Support Services	$31,500 Hourly
TOTAL HOURLY and ALLOWANCES	**$161,000**

For allowances and hourly items, services will be billed on an hourly basis in accordance with the current McKim & Creed yearly hourly rate schedule subject to be adjusted annually. Printing and postage shall be billed as reimbursable expenses at actual cost incurred plus 15%. Mileage shall be billed at the current

IRS rate. Company vehicles and trucks shall be billed at the M&C rate currently $0.85 per mile.

For all hourly billed services, the monthly invoice will be itemized by employee classification and the current hourly rate. Reimbursable items will also be itemized by type of expense.